PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Magnussen, *et al.*	)	Examiner: Mark O. Budd
Appl. No.:	09/801,194	)	Group Art Unit: 2834
Filed:	03/08/2001	)	
For:	VIBRATORY MOTORS AND METHODS OF MAKING AND USING SAME	)	

SECOND AMENDMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In response to the Office Action mailed January 29, 2003, please amend the above-identified application as follows:

Please amend the claims as follows:

27. (Twice Amended) A vibratory system for moving a driven element, the vibratory system including the driven element and comprising: a vibratory element having a driving element comprising one of a piezoelectric element and a magnetorestrictive element in driving communication with a resonator that has a selected contacting portion positioned to drivingly engage the driven element during use of the vibratory system; a resilient element having one end connected to a base and an opposing end connected to the vibratory element to resiliently urge the selected contacting portion against the driven element during use of the vibratory system, the vibratory element and the resilient element being configured to cooperate to comprise means for causing the selected contacting portion to move in a first elliptical motion when the vibratory element is excited to simultaneously resonate in at least two vibration modes by a first signal at a single, first frequency with a single phase provided to the driving element, the elliptical motion

occurring without engagement with the driven element, the motion being of sufficient amplitude to move the driven element during operation of the system, and with the first elliptical motion having a major axis inclined at an angle β_1 with respect to a tangent along a direction of motion of a driven element at the selected contacting portion, with the angle β_1 being between about 5-85 degrees when the selected contacting portion is drivingly engaging the driven element during operation of the system.

47. (Twice Amended) A vibratory system having at least one source of vibration drivingly connected to vibrate a resonator to amplify the vibration, the resonator having a selected contacting portion located to be engaged with a driven element to move the driven element in at least a predetermined direction, the vibratory system including the driven element, the vibratory system comprising: a configuration of resonator and driven element that cooperate to comprise means for causing the selected contacting portion to move in a first elliptical path when excited by a first electrical signal, the elliptical path having a major axis and minor axis, the major axis being inclined at an angle β_1 with respect to a tangent to the driven element at the selected contacting portion in the direction of motion of the driven element, the angle β_1 being between about 5-85 degrees; and

said means further moving the selected contacting portion in a second elliptical path when excited by a second electrical signal sufficient to cause a second motion of the selected contacting portion, the second elliptical path having a major axis and minor axis, the major axis being inclined at an angle β_2 with respect to a tangent to the driven element at the selected contacting portion and in the direction of motion of the driven element, the angle β_2 being between about 5-85 degrees.

58. (Once Amended) A vibratory element having a source of vibration vibrating a resonator to amplify the vibration, the resonator having a selected contacting portion located to be engaged with a driven element to move the driven element in a predetermined direction during use of the vibratory element, the vibratory element further having a means comprising a single, first electrical signal at a single, first frequency with a single phase being applied to the source of vibration and exciting the resonator for moving the selected contacting portion in a first elliptical path having a major and minor axis which are not aligned with a predominant axis of the

vibrating element by a defined angle that varies by less than about 10 degrees when the first frequency varies by about 200 Hz or more on either side of the first frequency.

66. (Once Amended) A vibratory component for moving a driven element, the vibratory component comprising:

a piezoelectric vibration source mounted to a resonator to form a vibrating element; the vibrating element having a selected contacting portion located to engage the driven element during use, the selected contacting portion moving in a first elliptical path having a major axis and minor axis when the vibration source is excited by means including only a single first electrical signal for causing at least two vibration modes that are superimposed to create the first elliptical path, the first electrical signal being amplified sufficiently to cause at least one off-resonance vibration mode to produce a motion of the selected contacting portion having sufficient amplitude that the resulting elliptical path can move the driven element during use.

72. (Once Amended) A vibratory system for moving a driven element, comprising:

a driven element movable in at least a first direction;

a vibration source mounted to a resonator to form a vibrating element; the vibrating element having a selected contacting portion located to engage and move the driven element, the at least one of the vibration source and vibrating element forming means for moving the selected contacting portion in a first elliptical path, wherein a longitudinal axis of the vibrating element is inclined at an angle α to a tangent to the driven element in the first direction at the selected contacting portion, the angle α being between about 10 and 80 degrees when the selected contacting portion is drivingly engaging the driven element;

a signal generator providing a first signal at a first, single frequency having a single phase to the vibrating element to cause the elliptical motion;

a resilient mount connected to the vibrating element.

118. (Twice Amended) A vibratory system for moving a driven element, the system including the driven element, the system comprising:

a vibratory element having a source of vibration that converts electrical energy directly to physical motion, the vibratory element having a predominant axis and having a selected contacting portion located to be engaged with the driven element at an angle α to a tangent to the driven element in the first direction at the selected contacting portion, the angle α being between

about 10 and 80 degrees when the selected contacting portion is drivingly engaging the driven element, the angle α being selected to move the driven element along a driven path during use, wherein the vibratory element comprises means excited with a first, single electrical signal having a single phase for vibrating at a first frequency in a first vibration mode having sufficient motion along a first axis that the selected contacting portion moves along a first path to cause the driven element to move in a first direction, at least one of a resonator for the vibrating element and a resilient mounting system for the vibrating element being provided and configured to achieve the first path; the vibratory element further comprising means excited with a second electrical signal to vibrate at a second frequency in a second vibration mode having sufficient motion that the selected contacting portion moves along a second path to move the driven element in a second direction, at least one of the resonator and resilient mounting system for the vibrating element being provided and configured to achieve the second path.

124. (Once Amended) A vibratory system for moving a driven element, the system having a source of vibration that converts electrical energy directly into physical motion and causing a resonator with a selected contacting portion to drivingly engage the driven element, the selected contacting portion maintaining sufficient contact with the driven element to move the driven element during operation of the system, the system comprising:

a signal generator electrically connected to the source of vibration, the signal generator producing a first and second signal, each signal being communicated to the vibration source through the same electrical connection to the source of vibration, means for moving the selected contacting portion and the driven element in a first direction when the source of vibration is driven by the first signal, and moving the driven element in a second direction when the source of vibration is driven by the second signal, and further moves in the first direction when a single sinusoidal signal of a first frequency is applied, and can also move in the first direction when the first frequency is dominant and superimposed with plural sinusoidal signals of different frequencies, the second signal either not occurring simultaneously with the first signal or being of substantially different amplitude if it occurs simultaneously with the first signal.

127. (Once Amended) A vibratory system for moving a driven element in a first and second direction, the system including the driven element and comprising:

a vibratory element in driving communication with a resonator that has a selected contacting portion positioned to drivingly engage the driven element during use of the vibratory system to move the driven element in the first and second direction, the vibratory element comprising means for moving the selected contacting portion in a first and second elliptical paths each having a major and minor axis, at least one of the major and minor axes not coinciding with the direction of motion resulting from the elliptical path with which the axis is associated, the vibrating element resonating when excited by a first signal having a first frequency to cause the first elliptical path to move the driven element in the first direction, and further resonating when excited by a second signal having a second frequency to cause the second elliptical path to move the driven element in the second direction, each signal being communicated to the vibratory element through the same electrical connection to the vibratory element, the resonator having a longitudinal axis that is inclined at an angle α. to a tangent to the driven element in the first direction at the selected contacting portion, the angle α being between about 10 and 80 degrees when the selected contacting portion is drivingly engaging the driven element.

130. (Once Amended) The vibratory system of Claim 127, wherein the resonator comprises an elongated member having an opening defined by at least two opposing sidewalls, and wherein the opening further includes two opposing first and second end walls on the longitudinal axis, the vibration element being held in compression under a defined preload by said opposing end walls, the end walls having one of a right-angled corner and a shaped surface leading to at least one of the first and second end walls to help press-fit the vibratory element into the opening and wherein the resonator further comprises:

a first section extending between a first and a second plane each of which is perpendicular to the longitudinal axis and spaced apart to completely include the selected contacting portion and spaced no further apart than needed to completely include the selected contacting portion;

a second section extending between a third and a fourth plane each of which is perpendicular to the longitudinal axis and spaced apart to completely include the first end wall and any shaped surface leading to the first end wall and spaced no further apart than needed to completely include said first end wall and said shaped surface;

a third section extending between a fifth and a sixth plane each perpendicular to the longitudinal axis and spaced apart to completely include the second end wall and any shaped

surface leading to the second end wall and spaced no further apart than needed to completely embrace said second end wall and any shaped surface leading to said second end wall; and

wherein the resonator has a second axis perpendicular to the longitudinal axis and having portions of the resonator extending between the second and third planes and extending between the fourth and fifth planes such that, excluding the first, second and third sections, every cross-section of the resonator perpendicular to the second axis is the same.

132. (Once Amended) The vibratory system of Claim 80, wherein the resonator comprises an elongated member having an opening defined by at least two opposing sidewalls, and wherein the opening further includes two opposing first and second end walls on the longitudinal axis, the vibration element being held in compression under a defined preload by said opposing end walls, the end walls having one of a right-angle corner and a shaped surface leading to at least one of the first and second end walls to help press-fit the vibratory element into the opening and wherein the resonator further comprises:

a first section extending between a first and a second plane each of which is perpendicular to the longitudinal axis and spaced apart to completely include the selected contacting portion and spaced no further apart than needed to completely include the selected contacting portion;

a second section extending between a third and a fourth plane each of which is perpendicular to the longitudinal axis and spaced apart to completely include the first end wall and any shaped surface leading to the first end wall and spaced no further apart than needed to completely include said first end wall and said shaped surface;

a third section extending between a fifth and a sixth plane each perpendicular to the longitudinal axis and spaced apart to completely include the second end wall and any shaped surface leading to the second end wall and spaced no further apart than needed to completely embrace said second end wall and any shaped surface leading to said second end wall; and

wherein the resonator has a second axis perpendicular to the longitudinal axis and having portions of the resonator extending between the second and third planes and extending between the fourth and fifth planes such that, excluding the first, second and third sections, every cross-section of the resonator perpendicular to the second axis is the same.

134. (Once Amended) The vibratory system of Claim 54, wherein the resonator comprises an elongated member having a longitudinal axis, and wherein the opening further

includes two first and second opposing end walls on the longitudinal axis, the source of vibration being held in compression under a defined preload by said opposing end walls, the end walls having one of a right-angled corner and a shaped surface leading to at least one of the first and second end walls to help press-fit the vibratory element into the opening and wherein the resonator further comprises:

a first section extending between a first and a second plane each of which is perpendicular to the longitudinal axis and spaced apart to completely include the selected contacting portion and spaced no further apart than needed to completely include the selected contacting portion;

a second section extending between a third and a fourth plane each of which is perpendicular to the longitudinal axis and spaced apart to completely include the first end wall and any shaped surface leading to the first end wall and spaced no further apart than needed to completely include said first end wall and said shaped surface;

a third section extending between a fifth and a sixth plane each perpendicular to the longitudinal axis and spaced apart to completely include the second end wall and any shaped surface leading to the second end wall and spaced no further apart than needed to completely embrace said second end wall and any shaped surface leading to said second end wall; and

wherein the resonator has a second axis perpendicular to the longitudinal axis and having portions of the resonator extending between the second and third planes and extending between the fourth and fifth planes such that, excluding the first, second and third sections, every cross-section of the resonator perpendicular to the second axis is the same.

135. (Once Amended) The vibratory element of Claim 61, wherein the resonator comprises an elongated member having a longitudinal axis and further having an opening defined by at least two opposing sidewalls, and wherein the opening further includes two opposing first and second end walls on the longitudinal axis, the piezoelectric element being held in compression under a defined preload by said opposing end walls, the end walls having one of a right-angled corner and a shaped surface leading to at least one of the first and second end walls to help press-fit the vibratory element into the opening and wherein the resonator further comprises:

a first section extending between a first and a second plane each of which is perpendicular to the longitudinal axis and spaced apart to completely include the selected contacting portion and spaced no further apart than needed to completely include the selected contacting portion;

a second section extending between a third and a fourth plane each of which is perpendicular to the longitudinal axis and spaced apart to completely include the first end wall and any shaped surface leading to the first end wall and spaced no further apart than needed to completely include said first end wall and said shaped surface;

a third section extending between a fifth and a sixth plane each perpendicular to the longitudinal axis and spaced apart to completely include the second end wall and any shaped surface leading to the second end wall and spaced no further apart than needed to completely embrace said second end wall and any shaped surface leading to said second end wall; and

wherein the resonator has a second axis perpendicular to the longitudinal axis and having portions of the resonator extending between the second and third planes and extending between the fourth and fifth planes such that, excluding the first, second and third sections, every cross-section of the resonator perpendicular to the second axis is the same.

136. (Once Amended) The vibratory system of Claim 74, wherein the resonator comprises an elongated member having a longitudinal axis and further having an opening defined by at least two opposing sidewalls, and wherein the opening further includes two opposing first and second end walls on the longitudinal axis, the piezoelectric element being held in compression under a defined preload by said opposing end walls, the end walls having one of a right-angled corner and a shaped surface leading to at least one of the first and second end walls to help press-fit the vibratory element into the opening and wherein the resonator further comprises:

a first section extending between a first and a second plane each of which is perpendicular to the longitudinal axis and spaced apart to completely include the selected contacting portion and spaced no further apart than needed to completely include the selected contacting portion;

a second section extending between a third and a fourth plane each of which is perpendicular to the longitudinal axis and spaced apart to completely include the first end wall and any shaped surface leading to the first end wall and spaced no further apart than needed to completely include said first end wall and said shaped surface;

a third section extending between a fifth and a sixth plane each perpendicular to the longitudinal axis and spaced apart to completely include the second end wall and any shaped surface leading to the second end wall and spaced no further apart than needed to completely embrace said second end wall and any shaped surface leading to said second end wall; and

wherein the resonator has a second axis perpendicular to the longitudinal axis and having portions of the resonator extending between the second and third planes and extending between the fourth and fifth planes such that, excluding the first, second and third sections, every cross-section of the resonator perpendicular to the second axis is the same.

137. (Once Amended) The vibratory system of Claim 118, wherein the resonator comprises an elongated member having a longitudinal axis and further having an opening defined by at least two opposing sidewalls, and wherein the opening further includes two opposing first and second end walls on the longitudinal axis, the source of vibration being held in compression under a defined preload by said opposing end walls, the end walls having one of a right-angled corner and a shaped surface leading to at least one of the first and second end walls to help press-fit the vibratory element into the opening and wherein the resonator further comprises:

a first section extending between a first and a second plane each of which is perpendicular to the longitudinal axis and spaced apart to completely include the selected contacting portion and spaced no further apart than needed to completely include the selected contacting portion;

a second section extending between a third and a fourth plane each of which is perpendicular to the longitudinal axis and spaced apart to completely include the first end wall and any shaped surface leading to the first end wall and spaced no further apart than needed to completely include said first end wall and said shaped surface;

a third section extending between a fifth and a sixth plane each perpendicular to the longitudinal axis and spaced apart to completely include the second end wall and any shaped surface leading to the second end wall and spaced no further apart than needed to completely embrace said second end wall and any shaped surface leading to said second end wall; and

wherein the resonator has a second axis perpendicular to the longitudinal axis and having portions of the resonator extending between the second and third planes and extending between the fourth and fifth planes such that, excluding the first, second and third sections, every cross-section of the resonator perpendicular to the second axis is the same.

138. (Once Amended) A vibratory component for use with a vibratory system to move a driven element, the vibratory component having a source of vibration mounted to a resonator to form a vibrating element, the resonator comprising:

a selected contacting portion located to engage the driven element during use;

an elongated member having a longitudinal axis;

an opening defined by at least two opposing sidewalls, the opening further including two opposing first and second end walls on the longitudinal axis, the source of vibration being held in compression under a defined preload by said opposing end walls, the end walls having one of a right-angled corner and a shaped surface leading to at least one of the first and second end walls to help press-fit the vibratory element into the opening;

a first section extending between a first and a second plane each of which is perpendicular to the longitudinal axis and spaced apart to completely include the selected contacting portion and spaced no further apart than needed to completely include the selected contacting portion;

a second section extending between a third and a fourth plane each of which is perpendicular to the longitudinal axis and spaced apart to completely include the first end wall and any shaped surface leading to the first end wall and spaced no further apart than needed to completely include said first end wall and said shaped surface;

a third section extending between a fifth and a sixth plane each perpendicular to the longitudinal axis and spaced apart to completely include the second end wall and any shaped surface leading to the second end wall and spaced no further apart than needed to completely embrace said second end wall and any shaped surface leading to said second end wall;

wherein the resonator has a second axis perpendicular to the longitudinal axis and having portions of the resonator extending between the second and third planes and extending between the fourth and fifth planes such that, excluding the first, second and third sections, every cross-section of the resonator perpendicular to the second axis is the same; and

wherein the vibratory component vibrates in a first mode in the plane spanned by the first and second axes when the source of vibration is excited by a first electrical signal with a single, first frequency, said mode being neither a pure bending nor a pure longitudinal mode of the vibratory component, wherein the resulting motion of the contacting portion has a sufficient